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Diet quality in Canada

by Didier Garriguet

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Abstract

Background

In addition to recommendations about the consumption of specific foods and nutrients, a measure of overall diet quality is useful. Over the years, a number of countries, but not Canada, have developed indexes to evaluate diet quality.

Data and methods

The *American Healthy Eating Index* was adapted to conform to recommendations in Canada's Food Guide. Data from 33,664 respondents to the 2004 Canadian Community Health Survey–Nutrition were used. Usual index scores were calculated with the Software for Intake Distribution Estimation program. Multiple linear regression models were used to examine associations between index scores and various characteristics, particularly the frequency of vegetable and fruit consumption.

Results

For the population aged 2 or older, the average score on the Canadian adaptation of the Healthy Eating Index in 2004 was 58.8 out of a possible 100 points. Children aged 2 to 8 had the highest average scores (65 or more). Average scores tended to fall into early adolescence, stabilizing around 55 at ages 14 to 30. A gradual upturn thereafter brought the average score to around 60 at age 71 or older. At all ages, women's scores exceeded those of men. The frequency of vegetable and fruit consumption was linked to index scores.

Interpretation

The American *Healthy Eating Index* can be adapted to Canadian food intake recommendations. Canadian Community Health Survey questions about the frequency of vegetable and fruit consumption can be used as an approximation of diet quality.

Keywords

diet, dietary habits, eating, food intake, fruit, nutrition, nutrition surveys, vegetables

Author

Didier Garriguet (613-951-7187; Didier.Garriguet@statcan.gc.ca) is with the Health Analysis Division at Statistics Canada, Ottawa, K1A 0T6.

Recommendations about what to eat, how much and what to avoid are designed to help prevent or control chronic conditions and diseases such as osteoporosis, high blood pressure, cardiovascular disease, anemia, diabetes and obesity.[1] In Canada, such recommendations come from a number of sources, notably, *Canada's Food Guide*,[2] Dietary Reference Intakes[1] (a joint Canada-US initiative) published by the Institute of Medicine, and organizations targeting specific diseases, such as the Heart and Stroke Foundation and the Canadian Diabetes Association.

Beyond specific prescriptions and proscriptions, a multidimensional measure—an index—of overall diet quality is useful. With such a measure, it is possible to evaluate the nutritional health of populations, trace trends in eating habits, compare different groups, and assess the value of qualitative indicators of eating habits.

Over the years, several diet quality indexes have been developed.[3-11] These indexes assess as many as four aspects of diet quality: adequacy, moderation, variety and balance. Adequacy is a measure of the sufficiency of intake of nutrients and foods; moderation, whether certain nutrients or foods are consumed in excess; variety, the diversity of food choices; and balance, the equilibrium of food intake.

Because nutrition recommendations in Canada and the United States are similar, the 2005 version of the American *Healthy Eating Index* can be adapted to the Canadian situation.[4] This article presents an adaptation of that index and briefly outlines results for Canada based on data from the 2004 Canadian Community Health Survey–Nutrition. The index is also used to evaluate the Canadian Community Health Survey module on vegetable and fruit consumption as an indicator of diet quality.

Methods

Data source

The data are from cycle 2.2 of the Canadian Community Health Survey.

The survey covers the household population, excluding members of the regular Canadian Forces; residents of the three territories, of certain remote areas and of institutions; and all residents (military and civilian) of Canadian Forces bases. Detailed descriptions of the survey design, sample and interview methods are available in a published report.[12] Cycle 2.2, conducted in 2004, was the first national survey of Canadians' eating habits in more than 30 years.

A 24-hour dietary recall was used to estimate food and nutrient intake. A total of 35,107 people completed an initial recall; three to ten days later, a subsample of 10,786 completed a second recall. Response rates were 76.5% and 72.8%, respectively.

This study deals with the population aged 2 or older, the age group to whom the recommendations in the 2007 publication, *Canada's Food Guide*, apply. Respondents whose food intake was null (15) or invalid (43), children younger than age 2 (1,088), women who were pregnant (175) or breastfeeding (92), and children who were being breastfed (30) were excluded. The study pertains to 33,664 people, 10,352 of whom completed the second 24-hour dietary recall.

To help respondents remember what and how much they ate and drank the previous day, interviewers used the Automated Multiple Pass Method,[13,14] which consists of five steps:

- a quick list (respondents reported all foods and drinks they had consumed);
- a series of questions about specific food categories and frequently forgotten foods;
- questions about the time and type of meal;
- a series of questions seeking more detailed information about the foods, drinks and quantities consumed; and
- a final review.

The caloric and nutrient content of the foods reported was derived from Health Canada's Canadian Nutrient File 2001b supplement.[15]

Analytical techniques

The index developed in this study was calculated for each of the two 24-hour dietary recalls. The first recall was used to estimate average index scores for given populations. With the Software for Intake Distribution Estimation (SIDE),[16,17] the two recalls were used together to estimate usual index scores and the percentage of the population scoring below 50, 50 to 80, and more than 80.

The effect of selected socio-economic, lifestyle and health, and dietary characteristics on index scores was estimated with multiple linear regression. These estimates should be considered as regression-adjusted averages, since they are based only on the first recall.

The bootstrap method, which takes account of the complex survey design,[18-20] was used to estimate confidence intervals. The significance level was set at 0.05.

Definitions

Foods (basic foods, recipes or ingredients) were classified according to the four food groups in the 1992 publication, *Canada's Food Guide to Healthy Eating for People Four Years Old and Over*[21]— vegetables and fruit, milk products, meat and alternatives, and grain products—and the "other foods" category. The 2007 classification was not available when this analysis was conducted. No food was counted twice; for example, if a recipe was classified in the "other foods" category, the recipe was used rather than the ingredients, and vice versa.

The American 2005 *Healthy Eating Index* definition of whole fruits excludes fruit juice from total fruit. The definition of whole fruits in the Canadian adaptation is the same, but also excludes vegetable juice from total vegetables and fruit. Fruit and vegetable juice correspond to the Bureau of Nutritional Sciences groups 45A, 46C, 231E and 231F.

Dark green and orange vegetables were identified based on a list published by Health Canada.[22] The category excludes legumes and some fruits that can be substituted for orange vegetables, such as apricots, cantaloupes, mangoes, nectarines, papayas and peaches.

Whole grain products were identified based on Bureau of Nutritional Sciences groups and the list published by Health Canada.[23]

Frequency of consumption of vegetables and fruit was not determined from the 24-hour recall, but from survey questions about the number of times a day respondents ate vegetables and fruit. It is the sum of the frequency with which respondents reported consuming six categories of foods: fruit juice; fruit excluding juice; green salad; potatoes (excluding fries, hash browns and chips); carrots; and other vegetables.

Two other diet quality variables are considered in the analysis: *vitamin and mineral consumption* in the 30 days before the interview (yes or no) and *frequency of adding salt at the table* (never, rarely, sometimes, often).

In addition to *age* and *sex*, the sociodemographic variables considered in the analysis are *highest level of education in the household* (less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation), *immigrant status*, *Aboriginal status* and *household income*. Household income was based on total self-reported household income from all sources in the previous 12 months. The ratio between total household income and the low-income cutoff corresponding to the number of people in the household and community size was calculated. The ratios were adjusted by dividing them by the highest ratio for all respondents. The adjusted ratios were grouped into quintiles.

The lifestyle and health variables are: *smoking status*, with smokers defined as those who smoke every day or occasionally; *alcohol consumption* (yes or no) during the 12 months before the interview; *leisure-time physical activity* (inactive, moderately active, active) defined in terms of average daily energy expenditure, based on the frequency and duration of all leisure-time physical activities in which respondents participated during the three months before the interview and the metabolic energy expenditure of each activity;

and *self-reported health* (excellent, very good, good, fair, poor).

Alcohol consumption, smoking status, leisure-time physical activity and self-reported health are not available for respondents younger than 12.

A healthy eating index for Canada

The Healthy Eating Index

The *Healthy Eating Index* was developed by the United States Department of Agriculture to measure the quality of Americans' diets. The original 1995 version[3] was based on the *Dietary Guidelines for Americans* and the *Food Guide Pyramid*.[2,4] The *Index* was revised in 2005[5] after publication of a new version of the *Dietary Guidelines*.

The *Healthy Eating Index* assesses two aspects of diet quality: adequacy and moderation. The maximum possible score is 100 points. All components are measured continuously and are reported in relation to energy consumption (Table 1). Intake between 0 and the maximum number of points possible for each component is prorated linearly. For the sake of comparability in this analysis, amounts were converted into the equivalent of "servings" in the most recent (2007) recommendations in *Canada's Food Guide*.[2] Details on the how the components are defined and the foods included in some of the less evident components are available in a technical report.[4]

Table 1
Components of American 2005 *Healthy Eating Index*, range of scores and scoring criteria

Component	Range of scores	Scoring criteria
Adequacy*	**0 to 60 points**	
Total fruit	0 to 5 points	Minimum: 0 Maximum: 1.6 servings per 1,000 kilocalories
Whole fruit	0 to 5 points	Minimum: 0 Maximum: 0.8 servings per 1,000 kilocalories
Total vegetables	0 to 5 points	Minimum: 0 Maximum: 2.2 servings per 1,000 kilocalories
Dark green and orange vegetables and legumes	0 to 5 points	Minimum: 0 Maximum: 0.8 servings per 1,000 kilocalories
Total grains	0 to 5 points	Minimum: 0 Maximum: 3 servings per 1,000 kilocalories
Whole grains	0 to 5 points	Minimum: 0 Maximum: 1.5 servings per 1,000 kilocalories
Milk	0 to 10 points	Minimum: 0 Maximum: 1.3 servings per 1,000 kilocalories
Meat and beans	0 to 10 points	Minimum: 0 Maximum: 75 grams per 1,000 kilocalories
Oils (non-hydrogenated vegetable oil or oil in fish, nuts, seeds)	0 to 10 points	Minimum: 0 Maximum: 12 grams per 1,000 kilocalories
Moderation†	**0 to 40 points**	
Saturated fats	8 to 10 points 0 to 8 points	Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake
Sodium	8 to 10 points 0 to 8 points	Minimum 700 milligrams to 1,100 milligrams per 1,000 kilocalories 1,100 milligrams to maximum 2,000 milligrams per 1,000 kilocalories
Solid fats, alcohol and sugar	0 to 20 points	Minimum: 20% of total energy intake Maximum: 50% of total energy intake

* for adequacy components, 0 points for minimum or less, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum

† for moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more, and proportional for amounts between minimum and maximum

Note: Amounts recommended in the American *Healthy Eating Index* were converted into the equivalent of servings in *Canada's Food Guide*

Source: Reference 4

Adaptation to Canadian recommendations

Although Canadian and American dietary guidelines differ slightly (Appendix Tables B and C), the *Food Pyramid* in the United States and *Canada's Food Guide* are designed to meet generally similar recommendations. As a result, the 2005 *Healthy Eating Index* is relatively easy to adapt for Canada.

The American *Index* uses a proportional approach to energy intake—recommended intake of various types of food is expressed per 1,000 calories of total intake. (A diet averaging 2,150 calories a day for an adult is assumed.) To adapt this index for Canada, recommendations are expressed as number of servings, according to age and sex, as specified in the 2007 version of *Canada's Food Guide*.[2] As noted above, the 1992 classification of food groups was used (see *Definitions*) because it was the only one available when the analysis was conducted.

The Canadian adaptation is comprised of eight *adequacy* components (total vegetables and fruit, whole fruit, dark green and orange vegetables, total grain products, whole grains, milk and alternatives, meat and alternatives, and unsaturated fats) and three *moderation* components (measuring saturated fats, sodium, and "other food") (Table 2). For the eight adequacy components, points between 0 and the potential maximum score are assigned proportionally.

Guidelines in Canada and the United States recommend around two servings of dark green or orange vegetables a day, and the consumption of whole fruits (and vegetables) rather than juice. The Canadian threshold was set in terms of the American threshold, but is expressed as a percentage of total vegetable and fruit intake. Specifically, 0.8 servings of whole fruit or dark green and orange vegetables per 1,000 calories represents 21% (1.6 servings + 2.2 servings) of the recommended number of servings of vegetables and fruit. Some dark green

Table 2
Components of Canadian adaptation of *Healthy Eating Index*, range of scores and scoring criteria

Component	Range of scores	Scoring criteria
Adequacy[†]	**0 to 60 points**	
Total vegetables and fruit	0 to 10 points	Minimum: 0 Maximum: 4 to 10 servings*
Whole fruit	0 to 5 points	Minimum: 0 Maximum: 0.8 to 2.1 servings (21% of recommendation for total vegetables and fruit)*
Dark green and orange vegetables	0 to 5 points	Minimum: 0 Maximum: 0.8 to 2.1 servings (21% of recommendation for total vegetables and fruit)*
Total grain products	0 to 5 points	Minimum: 0 Maximum: 3 to 8 servings*
Whole grains	0 to 5 points	Minimum: 0 Maximum: 1.5 to 4 servings (50% of recommendation for total grain products)*
Milk and alternatives	0 to 10 points	Minimum: 0 Maximum: 2 to 4 servings*
Meat and alternatives	0 to 10 points	Minimum: 0 Maximum: 1 to 3 servings (75 to 225 grams)*
Unsaturated fats	0 to 10 points	Minimum: 0 Maximum: 30 to 45 grams*
Moderation[‡]	**0 to 40 points**	
Saturated fats	8 to 10 points 0 to 8 points	Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake
Sodium	8 to 10 points 0 to 8 points	Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level
"Other food"	0 to 20 points	Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake

* according to age and sex, as specified in *Canada's Food Guide*
† for adequacy components, 0 points for minimum or less, 5 or 10 for maximum or more, and proportional for amounts between minimum and maximum
‡ for moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more, and proportional for amounts between minimum and maximum

and orange vegetables are classified differently in the two countries; for this study, the Canadian classification was used.

In both countries, it is recommended that whole grains make up half of grain products.

To adhere to the recommendations in *Canada's Food Guide*, consumption of unsaturated fats (poly- and monounsaturated) is used to calculate the oil component in Canada.

For the moderation components, consumption levels of saturated fats in the American *Healthy Eating Index* are drawn directly from the *Dietary Guidelines for Americans*. *Canada's Food Guide*, too, recommends limiting consumption of saturated fats. No modification was made to this component for the adaptation of the index in this study.

The sodium component of the American *Index* is based on Institute of Medicine recommendations and is expressed per 1,000 calories consumed per day. The thresholds were established in relation to adequate intake (1,500 milligrams a day) and the tolerable upper intake level for an adult (2,300 milligrams a day). Because the Canadian recommendations vary by age and sex, the Institute of Medicine recommendations by age and sex were used as the thresholds consumption in the Canadian adaptation. Sodium consumption below adequate intake scores 10 points; consumption equal to the tolerable upper intake level scores 8 points; consumption exceeding twice that level scores 0; and for consumption between the tolerable upper intake level and twice the the tolerable upper intake level, scores between 0 and 8 are assigned proportionally. As is the case for the American *Index*, points above the tolerable upper intake level are assigned to prevent a flooring effect, since the usual sodium intake of the majority of the population (77% to 100%, depending on age and sex) exceeds the tolerable upper intake level.[25]

The final moderation component of the index, worth 20 points, pertains to "discretionary calories," a concept in the American *Food Guide Pyramid*, but not in *Canada's Food Guide*. The American *Index* assesses this component as calories derived from solid fats, alcohol and added sugar. For the Canadian adaptation, calories from "other foods" (as defined in the 1992 *Canada Food Guide*) represent the discretionary component. The American *Index* assigns 20 points for intake below 20% of calories, 0 points for intake greater than 50% of calories, and proportional points for intake between these levels, based on the 10th and 85th percentile of the distribution of daily energy intake from these sources. Application of the same reasoning to energy intake from "other foods" for the Canadian adaptation results in an interval from 5% to 40% of daily calories (Appendix Table A).

For the original 1995 *Healthy Eating Index*, the United States Department of Agriculture classified scores into diet quality categories: more than 80 points represented a good quality diet; 50 to 80 points, a diet that required improvement; and fewer than 50 points, a poor diet. These categories were not used for the 2005 version of the *Index*. However, these intervals were applied in the current study to define low, average and high scores on the Canadian adaptation.

Validation

One of the advantages of using the American *Healthy Eating Index* as a basis for constructing a Canadian index is that its content validity and construct validity have been evaluated.[4]

Content validity is the degree to which items in a measurement tool represent the universe of content for the concept being measured—in this case, the degree to which the components of a healthy eating index embody published nutrition guidelines. The American *Healthy Eating Index* is considered to have content validity because it captures the key concepts of the *Dietary Guidelines*.

Similarly, the Canadian adaptation reflects *Canada's Food Guide*. Based on 500 simulated diets that follow the recommendations in the *Guide*,[2] maximum points would be assigned on all adequacy components. As well, scores on the moderation components would be high. Median saturated fat intake would amount to 5.8% to 9.2% of daily calories,[2] which merits scores between 8.5 and 10. Median sodium intake[2] would yield scores between 4.6 and 8.7. The 500 simulated diets leave no discretionary calories for a sedentary individual. However, according to results from the 2004 Canadian Community Health Survey—Nutrition, around 5% of unsaturated fats calories in an average diet come from "other foods," so individuals adhering to *Canada's Food Guide* would receive scores close to 20 points on that component. Thus, diets in line with the *Guide's* recommendations would score 95 or more.

Construct validity seeks to determine if theoretical and empirical support for a specific measuring device exist. The American *Healthy Eating Index* is considered to have construct validity because menus developed by nutrition experts, such as the National Heart Lung and Blood Institute's *DASH Eating Plan*,[26] Harvard's *Healthy Eating Pyramid*,[27] and the American Heart Association's *No-Fad Diet*,[28] score high. As well, the *Index* can distinguish smokers from non-smokers (groups whose diets are known to be of different quality); is independent of calorie intake; and can detect meaningful differences by limiting floor and ceiling effects.[4] Similarly, on the Canadian adaptation, *DASH*, the *Healthy Eating Pyramid* and the *No-Fad Diet* score high, and smokers' scores are significantly lower than those of non-smokers, before and after adjustment for socio-economic, lifestyle, health and other dietary characteristics.

The American *Index* purports to be independent of calorie consumption, but calorie intake is correlated, to some extent, with scores on the Canadian adaptation. When calorie intake is included in the regression models, the coefficient differs significantly from 0 for people aged 12 or older (0.25 for each 100 kcal), but not for children (0.05 for each 100 kcal) (data not shown). However, this may be an artifact of under-reporting (see *Limitations*). In general, the ranges of values of the components of the Canadian adaptation are similar to those of the American *Index*.

Finally, principal component analysis and correlations between components showed the American *Index* to have more than one dimension. Principal component analysis of the Canadian adaptation reveals that at least four factors exist, confirming that multiple factors underlie it as well. The vegetables and fruit components and the percentage of calories coming from "other foods" have the highest correlations with the total score. Low correlations for dairy products and unsaturated fats indicate that the components measure another dimension of diet quality (Appendix Table D).

Results

Average index scores

In 2004, the average score on the Canadian adaptation of the healthy eating index was 58.8 for the total population aged 2 or older (Table 3). Almost 17% of the population scored below 50; fewer than 1% scored more than 80.

Children aged 2 to 8 had the highest index scores, averaging at least 65. Scores tended to fall in early adolescence, stablizing around 55 in the 14-to-30 age range. A gradual upturn through adulthood brought the average score to about 60 at age 71 or older. At all ages, women's index scores exceeded those of men.

Table 3
Average score on Canadian adaptation of *Healthy Eating Index* and percentage distribution of index score categories, by age group and sex, household population aged 2 or older, Canada excluding territories, 2004

			Percentage with index score:		
Age group	Sex	Average score	Less than 50	50 to 80	80 or more
Total	Both	58.8	16.6	82.9	0.5
2 or 3	Both	67.1	<3	97.5	<3
4 to 8	Both	65.4*	2.3E	96.5	1.2E
9 to 13	Boys	59.7*	8.7*E	91.3*	<3
	Girls	60.0*	7.9*E	92.1*	<3
14 to 18	Boys	54.3*	27.1*	72.9*	0
	Girls	55.6*†	25.5*	74.4*	<3
19 to 30	Men	54.0	28.9	71.1	<3
	Women	56.9†	20.0†	80.0†	<3
31 to 50	Men	56.4*	22.4	77.5	<3
	Women	60.2*†	13.0*†	86.4*†	<3
51 to 70	Men	57.7*	19.2	80.5	<3
	Women	61.3*†	10.4†	88.9†	0.7E
71 or older	Men	59.1	16.4	83.0	<3
	Women	62.4*†	6.8*†	92.2*†	1.1E

* significantly different from estimate for same sex in previous age group ($p<0.05$)
† significantly different from estimate for men ($p<0.05$)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
E use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2004 Canadian Community Health Survey—Nutrition

These patterns in average index scores were reflected in the percentages of various age-sex groups scoring below 50: fewer than 3% of children aged 2 to 8, but more than 25% of 14- to 18-year-olds of both sexes and of men aged 19 to 30. At age 71 or older, 16% of men, compared with 7% of women, scored below 50.

Effect of index components

The components of the index on which Canadians' scores tended to be relatively high (thereby raising overall scores) were total grain products (3.6 out of 5), meats and alternatives (7.4 out of 10), and unsaturated fats (8.3 out of 10) (Table 4). By contrast, relatively low scores on dark green and orange vegetables, whole fruits and whole grains, and the percentage of calories derived from "other foods" lowered overall scores.

Frequency of vegetable and fruit consumption

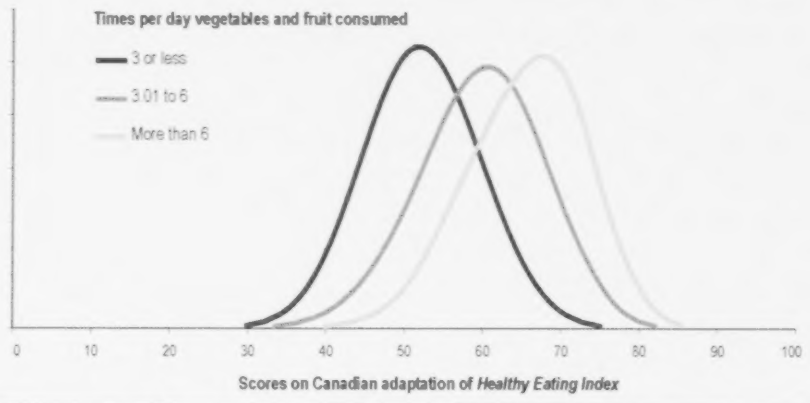
While a healthy eating index is a useful summary measure of diet quality, collecting the data necessary to construct it (through a 24-hour diet recall) is expensive and complicated. A comparison of the index scores in this analysis with other indicators of

Table 4
Average component scores on Canadian adaptation of *Healthy Eating Index*, household population aged 2 or older, Canada excluding territories, 2004

Component (maximum score possible)	Average score
Vegetables and fruit (10)	5.9
Dark green or orange vegetables (5)	1.4
Whole fruits (5)	2.4
Grain products (5)	3.6
Whole grain products (5)	1.6
Milk products (10)	5.5
Meat and alternatives (10)	7.4
Unsaturated fats (10)	8.3
Saturated fats (10)	6.5
Sodium (10)	5.6
Percentage of energy from "other foods" (20)	10.7

Source: 2004 Canadian Community Health Survey - Nutrition (first recall)

Figure 1
Distribution of scores on Canadian adaptation of *Healthy Eating Index*, by number of times per day vegetables and fruit consumed, household population aged 19 or older, Canada excluding territories, 2004



Source: 2004 Canadian Community Health Survey — Nutrition

Table 5
Average score on Canadian adaptation of *Healthy Eating Index* and percentage scoring less than 50, by number of times per day vegetables and fruit consumed, household population aged 19 or older, Canada excluding territories, 2004

Times per day vegetables and fruit consumed	Score			Percentage scoring less than 50		
		95% confidence interval			95% confidence interval	
	Average	from	to	Percentage	from	to
0 to 1	45.5	44.0	46.9	80.9	68.3	93.5
1.01 to 2	50.2	49.4	51.0	49.1	42.8	55.4
2.01 to 3	54.5	53.7	55.3	27.1	22.7	31.5
3.01 to 4	57.9	57.1	58.6	15.9	12.7	19.1
4.01 to 5	60.5	59.8	61.2	8.9	6.6	11.2
5.01 to 6	62.2	61.1	63.3	6.9[E]	4.2	9.6
6.01 to 7	64.7	63.5	65.8	3.7[E]	1.9	5.5
7.01 to 8	64.5	63.1	66.0	F	..	..
8.01 to 9	67.6	65.1	70.1	<3	..	..
9.01 to 10	66.5	63.6	69.5	<3	..	..
10.01 or more	63.9	59.9	68.0	F	..	..
3 or less	52.2	51.7	52.8	38.6	35.2	42.0
3.01 to 6	59.8	59.3	60.3	11.7	9.9	13.4
More than 6	65.1	64.3	65.9	2.7[E]	1.5	4.0

<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation more than 33.3%)
.. not applicable
Source: Canadian Community Health Survey—Nutrition, 2004

diet quality reveals the potential utility of other less cumbersome variables as measures of diet quality—for example, the frequency of vegetable and fruit consumption.

Figure 1 shows the distribution of index scores among adults aged 19 or older by their reported frequency of consuming vegetables and fruit (3 times a day or less, 3.01 to 6 times a day, or more than 6 times a day). As the frequency of vegetable and fruit consumption rose, so did average index scores (Table 5). For example, the average score of people who reported eating vegetables and fruit 3 times a day or less was 52.2; for those who reported more than 6 times a day, the average score was 65.1. And while 39% of people who reported eating vegetables and fruit 3 times a day or less scored below 50, this was the case for fewer than 3% of those who reported eating vegetables and fruit more than 6 times a day.

Linear regressions between index scores and several dietary, socio-economic, and lifestyle and health characteristics confirm the relationship between the frequency of vegetable and fruit consumption and index values. For children aged 2 to 11, eating vegetables and fruit more than 6 times a day raised index scores by an average of 3.8 points, compared with those who reported eating vegetables and fruit 3 to 6 times a day. For children whose consumption was 3 times a day or less, scores dropped an average of 5.4 points (Table 6). The corresponding results for people aged 12 or older were an average gain of 4.5 points, and an average loss of 5.7 points (Table 7).

Among children, taking vitamin and mineral supplements raised index scores, while adding salt at the table reduced them. A low level of household education had a negative effect on children's scores, but immigrant status had a positive effect. No significant associations emerged between children's scores and sex, household income or Aboriginal status.

Among people aged 12 or older, the associations between index scores and taking vitamin and mineral supplements or adding salt at the table were similar to those among children. Alcohol consumption lowered scores of this age group by an average of 1.8 points. Self-reported health, leisure-time physical activity and smoking status were also significantly associated with index scores. And as was the case for children, immigrant status and level of household education were significant, while Aboriginal status and household income were not. However, sex and age were significantly associated with index scores of people aged 12 or older.

Table 6
Average score and linear regression coefficient of Canadian adaptation of *Healthy Eating Index*, by selected dietary and socio-economic characteristics, household population aged 2 to 11, Canada excluding territories, 2004

Characteristics	Average score		Linear regression coefficient
	Average	Standard deviation	
Intercept	...	...	64.4
Dietary			
Times per day vegetables and fruit consumed			
3 or less	58.3*	0.5	-5.4§
3.01 to 6†	64.0	0.3	
More than 6	67.9*	0.4	3.8§
Consumption of vitamin and mineral supplements			
Yes	65.0*	0.3	1.2§
No†	63.3	0.3	
Adds salt at table			
Never†	64.7	0.3	
Rarely	64.0	0.4	-0.5
Occasionally	62.8*	0.6	-1.6§
Often	59.2*	1.1	-4.0§
Socio-economic			
Sex			
Boys	64.3	0.3	0.8
Girls†	63.7	0.3	
Highest level of education in household			
Less than secondary graduation	59.5*	0.8	-3.6§
Secondary graduation	62.1*	0.6	-1.5§
Some postsecondary	63.0	0.9	-1.1
Postsecondary graduation†	64.8	0.3	
Household income quintile			
First (lowest)	63.4*	0.5	-0.4
Second	63.0*	0.5	-1.4
Third	64.0	0.5	-0.5
Fourth	64.9	0.5	0.0
Fifth (highest)†	65.2	0.6	
Missing	64.8	0.9	0.5
Immigrant			
Yes	66.6*	0.9	3.2§
No†	63.9	0.2	
Aboriginal person			
Yes	60.7*	1.1	-1.1
No†	64.0	0.2	

† reference category
* significantly different from estimate for reference category ($p<0.05$)
§ coefficient significantly different from 0 ($p<0.05$)
... not applicable
Source: 2004 Canadian Community Health Survey—Nutrition

Table 7
Average score and linear regression coefficients of Canadian adaptation of *Healthy Eating Index*, by selected dietary, socio-economic, and lifestyle and health characteristics, household population aged 12 or older, Canada excluding territories, 2004

Characteristics	Average score		Linear regression coefficient
	Average	Standard deviation	
Intercept	...	...	60.0
Dietary			
Times per day vegetables and fruit consumed			
3 or less	52.2*	0.3	-5.7§
3.01 to 6†	59.5	0.2	...
More than 6	64.8*	0.4	4.5§
Consumption of vitamin and mineral supplements			
Yes	59.9*	0.3	1.1§
No†	57.0	0.2	...
Adds salt at table			
Never†	59.2	0.3	...
Rarely	59.3	0.3	0.2
Occasionally	57.2*	0.3	-1.0§
Often	54.9*	0.5	-2.4§
Socio-economic			
Sex			
Male	56.4*	0.2	-1.9§
Female†	59.9	0.2	...
Age group			
12 and 13	59.3*	0.5	0.0
14 to 18	55.0	0.3	-2.0§
19 to 30†	55.4	0.4	...
31 to 50	58.3*	0.3	2.4§
51 to 70	59.6*	0.3	2.8§
71 or older	61.1*	0.3	3.2§
Highest level of eduction in household			
Less than secondary graduation	56.4*	0.4	-1.8§
Secondary graduation	56.6*	0.5	-1.0§
Some postsecondary	55.8*	0.5	-1.6§
Postsecondary graduation†	58.8	0.2	...
Household income quintile			
First (lowest)	57.0*	0.4	0.2
Second	58.7	0.4	0.8
Third	57.9	0.4	0.4
Fourth	57.9	0.4	-0.1
Fifth (highest)†	58.8	0.4	...
Missing	58.6	0.4	0.6
Immigrant			
Yes	61.2*	0.4	2.7§
No†	57.3	0.2	...
Aboriginal person			
Yes	52.7*	0.9	-1.4
No†	58.2	0.2	...
Lifestyle and health			
Smoker			
Yes	52.6*	0.3	-4.4§
No†	59.8	0.2	...
Alcohol consumption			
Yes	57.5*	0.2	-1.8§
No†	60.0	0.3	...
Level of physical activity			
Active	59.7*	0.3	1.6§
Moderately active	59.3*	0.3	1.2§
Inactive†	57.0	0.2	...
Self-reported health			
Poor/Fair	55.6*	0.4	-1.8§
Good/Very good/Excellent†	58.4	0.2	...

† reference catgory
* significantly different from estimate for reference category ($p<0.05$)
§ coefficient significantly different from 0 ($p<0.05$)
... not applicable
Source: 2004 Canadian Community Health Survey—Nutrition

Discussion

Owing to the similarity between American and Canadian nutrition recommendations, the 2005 *Healthy Eating Index* can be adapted to the Canadian situation. The major difference in the adaptation presented in this study is the use of thresholds based on absolute quantities. A validation exercise similar to that conducted for the American *Index* shows that the Canadian adaptation is valid and represents multidimensional factors of diet quality.

Only a few direct comparisons between the American and Canadian indexes are possible. For saturated fat, one of the few components that can be compared, the average Canadian score is half a point more and slightly skewed toward higher values, and a larger percentage of Canadians scores 10. The sodium component is also skewed toward higher values in Canada. On the other hand, for discretionary calories, the Canadian component is skewed toward lower values, and the American component, toward higher values. Scoring is similar for the adequacy components, except for oils and unsaturated fats, with Americans scoring, on average, almost 3 points less than Canadians. However, oils and unsaturated fats are also the components on which definitions in the two countries differ the most.

A healthy eating index for Canada could have been based on a number of other indexes, but they are more difficult to adapt, largely because they contain a "variety" component. Even so, the adaptation presented in this article is just one among many possibilities. Although Health Canada's 2007 publication, *Canada's Food Guide*, was used as the source of nutrition recommendations, Health Canada was not involved in the development of this index.

While the frequency with which vegetables and fruit are consumed can differentiate diet quality, the optimal categorization remains to be established. Nonetheless, the use of 3 and 6 times a day as thresholds seems to maximize differences.

Limitations

Nutrition surveys are susceptible to under-reporting of energy intake. A recent validation of the collection instrument used by the Canadian Community Health Survey revealed that under-reporting averaged 11%,[29] and an earlier study showed under-reporting to average 10%.[30] Obese respondents were particularly likely to under-report how much they ate.

A possible way to overcome this limitation would have been to use a subsample of "plausible respondents"[31]—people whose reported calorie intake roughly corresponded to the amount they might be expected to eat, based on their age, sex, measured height, measured weight and reported leisure-time physical activity. However, the average index score of this group is only slightly higher than that of the full sample (59.5 rather than 58.1), and the coefficient for energy intake in the regression model no longer differs significantly from 0 (0.02 per 100 kcal) (data not shown). Thus, the effect of under-reporting calories consumed on the overall index score is minimal.

Another limitation of this analysis is that the results for frequency of vegetable and fruit consumption cannot be generalized to other cycles of the Canadian Community Health Survey. Compared with results for 2001 and 2007, the frequency of vegetable and fruit consumption in 2004 was 0.7 fewer occasions (data not shown). This difference may reflect the structure of the questionnaire. In 2004, the 24-hour dietary recall preceded the vegetable and fruit consumption questions, so respondents' answers to the food recall could have influenced their answers to these questions. For example, in 2004, lower percentages of people reported consuming fruit juice every day and a given number of times per week (data not shown). The effect was to shift the distribution of the frequency of vegetable and fruit consumption toward lower values. Nonetheless, the relationship between the frequency of vegetable and fruit consumption and the index is strong.

While recommendations published in 2007 in *Canada's Food Guide* were used to construct the index, the classification of foods is that of the 1992 *Canada Food Guide*, which was the only classification available when the data were analyzed. Some foods could be in different categories in the new classification.

Information about children younger than 6, which was provided by a parent, may not be accurate, particularly for meals consumed out of the parent's presence, at daycare, for example.

Finally, the physical activity variable pertains only to leisure-time activity, not to work-related activity such as manual labour, or to transportation that involves physical activity such as walking or bicycling.

Conclusion

A healthy eating index combines recommendations about various components of nutrition into a single measure of diet quality. In so doing, it transforms elements of what constitutes a "good" diet into a score that can be computed and compared.

On the index adapted from the American *Healthy Eating Index*, the average score for Canadians aged 2 or older was 58.8 out of a potential 100. One Canadian in six scored less than 50.

The results of this analysis suggest that variables other than an index based on the results of a 24-hour food recall might be used as measures of diet quality, notably, the frequency of fruit and vegetable consumption. ■

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Appendix

Table A
Cumulative percentage of daily energy intake from "other foods," by population percentile, household population aged 2 or older, Canada excluding territories, 2004

	Population percentile										
	10th	15th	20th	30th	40th	50th	60th	70th	80th	85th	90th
Percentage of daily energy intake from other foods (%)	5.0	7.1	9.1	12.7	16.3	19.9	23.7	28.5	34.2	38.1	43.2

Note: "Other foods" are defined according to 1992 Food Guide.
Source: 2004 Canadian Community Health Survey—Nutrition.

Table B
Recommended number of servings from each food group and unsaturated fat intake per day according to *Food Guide Pyramid*, by age group and sex

	Age group (years)							
	2 and 3	4 to 8	9 to 13	14 to 18	19 to 30	31 to 50	51 to 70	71 or older
Males								
Vegetables and fruit	4	6	8	10	10	10	9	9
Grain products	3	5	6	7	8	7	6	6
Milk products	2	2	3	3	3	3	3	3
Meat and alternatives	1	1.5	2	2	2.5	2	2	2
Unsaturated fats (grams)	15	17	24	29	31	29	27	27
Females								
Vegetables and fruit	4	5	7	8	9	8	7	7
Grain products	3	4	5	6	6	6	5	5
Milk products	2	2	3	3	3	3	3	3
Meat and alternatives	1	1	2	2	2	2	2	2
Unsaturated fats (grams)	15	17	22	24	27	24	22	22

Source: Reference 24

Table C
Recommended number of servings from each food group and unsaturated fat intake per day according to *Canada's Food Guide*, by age group and sex

	Age group (years)							
	2 and 3	4 to 8	9 to 13	14 to 18	19 to 30	31 to 50	51 to 70	71 or older
Males								
Vegetables and fruit	4	5	6	8	10	8	7	7
Total grain products	3	4	6	7	8	8	7	7
Milk products	2	2	3-4	3-4	2	2	3	3
Meat and alternatives	1	1	2	3	3	3	3	3
Unsaturated fats (grams)	30	30	30	45	45	45	45	45
Females								
Vegetables and fruit	4	5	6	7	8	7	7	7
Grain products	3	4	6	6	7	6	6	6
Milk products	2	2	3-4	3-4	2	2	3	3
Meat and alternatives	1	1	1	2	2	2	2	2
Unsaturated fats (grams)	30	30	30	30	30	30	30	30

Source: Reference 2.

Table D
Correlation between components of Canadian adaptation of *Healthy Eating Index*, household population aged 2 or older, Canada excluding territories, 2004

Components	Total score[1]	Vegetables and fruit	Dark green or orange vegetables	Whole fruit	Grain products	Whole grain products	Milk products	Meat and alternatives	Unsaturated fats	Saturated fats	Sodium	Percentage of energy from "other foods"
Total score	1.00											
Vegetables and fruit	0.40	1.00										
Dark green or orange vegetables	0.23	0.38	1.00									
Whole fruits	0.38	0.52	0.13	1.00								
Total grain products	0.20	0.08	-0.01	0.11	1.00							
Whole grain products	0.25	0.15	0.10	0.18	0.25	1.00						
Milk products	0.01	0.08	0.02	0.08	0.24	0.05	1.00					
Meat and alternatives	0.10	0.14	0.13	0.02	0.06	0.03	0.02	1.00				
Unsaturated fats	-0.02	0.15	0.05	0.02	0.34	0.04	0.25	0.41	1.00			
Saturated fats	-0.03	0.13	0.06	0.13	0.04	0.10	-0.34	-0.06	-0.27	1.00		
Sodium	-0.27	-0.18	-0.05	-0.00	-0.39	-0.04	-0.32	-0.29	-0.50	0.18	1.00	
Percentage of energy from "other foods"	0.26	0.22	0.09	0.21	0.16	0.16	0.13	0.09	-0.13	0.01	0.06	1.00

[1] total score minus specified components
Source: 2004 Canadian Community Health Survey—Nutrition